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Development of MIKIR E-Module Through Service-Learning Community Based Research

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Abstract: This study aims to develop an e-module based on MIKiR in improving students' mathematical abilities through the mathematical process and why it is necessary to develop and obtain a collaboration model of Lecturers, Teachers and Students in developing e-modules through community service-based research. This study is a RnD development research with the ASSURE model through Service-learning and Community Based Research (SLCBR). Based on the research results, it was concluded that (1) The importance of developing MIKiR e-modules through KKN community-based research, (2) The development of MIKiR e-modules through KKN community-based research produces valid and effective e-modules in facilitating active learning experiences, interaction, communication, and reflection (MIKiR), developing mathematical reasoning proof skills, representation connections, and communication (PRKoKo), and the mathematical process of inquiry-discovery and problem solving (PPPM), (3) The development of MIKiR e-modules through KKN community-based research produces practical e-modules in the form of ease of use of e-modules, efficiency of time use of e-modules, suitability to competencies, interesting, and can be used as independent learning, (4) The collaboration model of lecturers, teachers, and students in this research was designed based on the goals of each individual involved and what their respective responsibilities are in the research.

Keywords: Community Based Research; Service Learning; Mathematical Ability; Mathematical Process; MIKiR E-Module

Introduction

Information and Communication Technology (ICT) has profoundly transformed various aspects of life, including education. The integration of ICT in the classroom is essential for equipping students with 21st-century skills, ensuring they are prepared for a technologically driven future. Digital tools such as the internet and interactive multimedia are not only crucial for modern education but also require effective integration into teaching and learning processes, particularly within educational institutions and among education personnel (LPTK) (Ratheeswari, 2018). In line with this necessity, professional teachers must be adept at utilizing ICT in education (Minister of National Education, 2007), and both teachers and prospective teachers should possess the requisite knowledge and skills to integrate technology, pedagogy, and subject content into their teaching practices.

Numerous ICT applications have been integrated into mathematics education, including GeoGebra, Autograph, Desmos, Cabri-3D, and commonly used

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tools like Microsoft PowerPoint and Macromedia Flash. The role of technology in learning is twofold: from the teacher's perspective, it aids in information delivery, fosters student engagement, and serves as a visual tool to enhance comprehension. From the student's perspective, technology facilitates understanding of abstract concepts, enhances mathematical reasoning and problem-solving abilities, and encourages exploration and discovery. Given the critical role of technology in education, it is imperative to prioritize the development of digital tools that support teachers and prospective teachers in fostering effective learning environments (Ministry of Education, Culture, Research, and Technology Data Center, 2021).

One such integration of technology in education is the use of electronic modules (e-modules). E-modules are systematically designed, self-contained digital learning resources that provide interactive learning experiences through links, video tutorials, animations, and audio content (Ministry of Education and Culture, 2017). The adoption of e-modules presents several advantages: (1) teachers can monitor students' learning digitally, (2) learning extends beyond the classroom, (3) students engage in self-directed learning and problem-solving, (4) learning becomes more flexible and accessible anytime and anywhere (Hamzah & Mentari, 2017), and (5) students gain enriched learning experiences that enhance their knowledge acquisition (Jaenudin, Baedhowi, & Murwaningsih, 2017).

Despite the potential benefits, teachers still face challenges in integrating ICT into their teaching practices, including the development of e-modules that facilitate active learning, interaction, communication, and reflection. Existing studies highlight gaps in e-module development. For example, Matanluk et al. (2013) designed an e-module focusing on students' cognitive abilities, while Nursolekah & Suparman (2019) provided content and exercises without interactive multimedia. Similarly, Fonda & Sumargiyani (2018) developed an e-module without integrating teaching videos or tracking students' progress. These studies indicate a lack of comprehensive e-modules that support reasoning, proof, representation, connection, and communication skills through discovery-based learning and problem-solving.

Beyond content and structural organization, e-module development employs various applications such as Kvisoft Flipbook Maker Pro (Fonda & Sumargiyani, 2018), Digital Book (Asrial, Syahrial, Kurniawan, & Anandari, 2019), Adobe Flash CS6 (Fauziah, Sutrisno, & Suwarni, 2016), and Macromedia Flash (Syahrul, Murni, & Siregar, 2019). Additionally, applications like SIGIL facilitate e-book and e-module creation (Darma, Setyadi, Wilujeng, Jumadi, & Kuswanto, 2019; Ramadhani & Fitri, 2021). However, few studies have explored the use of free and accessible platforms like Google Sites for e-module publication, which could enhance accessibility and usability.

Most e-module development follows quantitative, mixed-method, or research and development (RnD) approaches. Previous studies have employed different methodologies, including mixed-method embedded design (Matanluk et al., 2013), RnD (Fonda & Sumargiyani, 2018; Syahrul, Murni, & Siregar, 2019), and the ADDIE and ASSURE models (Nursolekah & Suparman, 2019; Asrial et al., 2019; Fauziah et al., 2016; Darma et al., 2019; Ramadhani & Fitri, 2021). However, these studies have not incorporated a balanced collaboration between researchers, teachers, and students in the e-module development process.

A structured collaboration involving researchers, teachers, and students throughout the research process is essential to ensure meaningful and effective e-module development. This can be achieved through Service-Learning Community-Based Research (SLCBR), a framework that emphasizes practical, community-engaged learning (Kambau, Kadir, Mutmainnah, Jamilah, & Rahman, 2016). SLCBR integrates academic knowledge with community participation, providing solutions to real-world problems (Susilawaty, Tasruddin, Ahmad, & Salenda, 2016). Teachers and students function as equal partners in knowledge generation, maximizing the application of research findings (Small & Uttal, 2005; Wallerstein & Duran, 2017). By bridging theory and practice, SLCBR fosters collaborative research efforts that address educational challenges and enhance teacher-student engagement in learning improvement (Susilawaty et al., 2016).

Based on this review, the novelty of this study lies in: (1) structuring learning materials and pedagogical steps that actively engage students in experiencing, interacting, communicating, and reflecting on learning processes, thereby enhancing their reasoning, proof, representation, connection, and communication skills; (2) utilizing both PDF and web-based platforms (Google Sites) for e-module publication, ensuring free and widespread accessibility; and (3) implementing a collaborative model involving lecturers, teachers, and students through SLCBR to enhance the competency of educators and future educators in facilitating high-quality learning experiences.

Therefore, this study aims to develop a MIKiR-based e-module that fosters students' mathematical abilities through inquiry-based learning, with specific objectives to: (1) design and implement a MIKiR-based e-module to improve students' mathematical reasoning, and (2) establish a collaborative framework for lecturers,

teachers, and students in developing e-modules through Service-Learning Community-Based Research.

Method

This research is a RnD development research with the ASSURE model through Service-learning and Community Based Research (SLCBR). Development research (RnD) with the ASSURE model (Heinich, Molenda, Russel, & Smaldino, 2002); (Kim & Downey, 2016)consists of 6 stages, namely: (1) Analyze Learner: Analyze student characteristics (2) State Objective: Determine competencies; (3) Select Methods, Media, and Materials: Select methods, media and teaching materials; (4) Utilize Media and Materials: Utilize media and teaching materials; (5) Required Learner Participation: Involve students in the learning process; and (6) Evaluate and revise: Evaluate and revise.

Service Learning (Kambau et al., 2016) carried out through 3 stages: (1) Pre-Implementation: Initiating communication, cooperation and partnership agreements with communities/agencies, explanation of CBR-based service-learning, surveys and observations, and problem identification; (2) Implementation Stage: Service-learning practices, teacher involvement, third party involvement (Tanoto Foundation Facilitators), monitoring and evaluation; and (3) Post-Implementation: Reflection, comprehensive evaluation, and reporting.

Community Based Research(CBR) (Susilawaty, Tasruddin, Ahmad, & Salenda, 2016)carried out through 4 stages: (1) Laying down Basic Principles: Balanced collaboration in the research team, capacity is built internally not by experts unilaterally, and research results are designed to empower the researched community; (2) Planning: All stakeholders collaboratively design who will be involved in the research and what their roles will be; (3) Data Collection and Analysis: Community-based research involves all stakeholders fully in the entire process of data collection and analysis, researchers and stakeholders collaborate in designing and compiling research instruments, going into the field together to collect data and then analyzing the data collaboratively as well; and (4) Action on Findings.

The instruments used in this study were validation evaluation, observation sheets, questionnaires, and FGD discussion topic forms. Data collection techniques used were FGD, observation, surveys, and interviews. The evaluation of the e-module included the feasibility of the content and design. Based on the criteria above, an evaluation grid was created for the feasibility test of the e-module which refers to the MIKiR active learning indicators, mathematical abilities, and mathematical processes. The data obtained through the validation evaluation were in the form of qualitative and quantitative data. The development research focused on the development of e-modules that facilitate students to actively experience, interact, communicate, and reflect (MIKiR) to improve their reasoning and proof skills, representation, connection, and communication (PRKoKo) through the process of discovery and problem solving (PPPM) with a collaborative model of lecturers, teachers and students (Service-learning Community Based Research).

Data analysis in this study was conducted at each stage of development, both qualitative and quantitative data analysis. Qualitative data in the form of the results of the evaluation of the validation of the contents of the e-module by the research team and the Tanoto Foundation lecturer facilitator, while quantitative data in the form of the percentage of the effectiveness test of learning using the e-module.

Table 1. Research Flow Diagram

Stages	Activity Description
Initial Analysis	- Analyzing student characteristics (Analyze Learner) - Identifying problems through surveys and observations (CBR) - Communication and partnership agreements with communities/institutions (Service-Learning)
Planning	- Determining competencies and learning objectives (State Objective) - Designing methods, media, and learning materials (Select Methods, Media, and Materials) - Defining stakeholder roles in research (CBR)
Implementation	- Utilizing media and learning materials in the teaching process (Utilize Media and Materials) - Engaging students in the learning process (Required Learner Participation) - Implementing Service-Learning practices, involving teachers and third-party facilitators
Data Collection & Analysis	- Collecting data through FGD, observation, surveys, and interviews - Collaborative data analysis between researchers and stakeholders (CBR)
Evaluation & Revision	- Evaluating the feasibility of the e-module based on validation and feedback - Revising the module based on evaluation results (Evaluate and Revise) - Reflection and reporting research findings (Service-Learning)

Stages	Activity Description
Finalization & Publication	- Preparing the research report - Publishing research findings in the form of an e-module accessible to the education community

Results and Discussion

The Importance of E-Module Development

Teachers and prospective teachers/students must have the knowledge and skills to integrate technology, pedagogy, and learning content in the learning process. (Menteri pendidikan Nasioanal, 2007)in order to help students understand abstract concepts and materials to be more visual. Based on the results of observations and interviews, it is still difficult for teachers to develop e-modules that can facilitate students to actively experience, interact, communicate, and reflect in improving their reasoning and proof skills, representation, connections, and communication through the process of discovery and problem solving. One scheme that can be done is through collaboration between lecturers, teachers and students to develop e-modules.

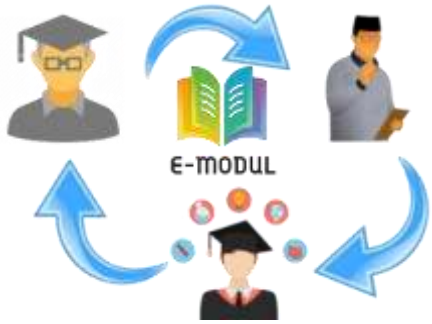

Figure 1. Collaboration Model between Lecturers, Teachers, and Students

The following are several reasons why the development of the MIKiR e-module through Service-Learning Community Based Research needs to be carried out: (1) Students have knowledge about learning, but cannot apply it directly, so service-learning needs to be carried out, (2) Teachers have teaching skills, but have difficulty developing innovative learning, so service-learning also needs to be carried out, and (3) Lecturers are obliged to disseminate knowledge through research and community service, so community-based research needs to be carried out.

Service-Learning Practice

Pre-implementation consists of activities to initiate communication with MTs Negeri 5 Kota Jambi institutions, conduct cooperation and partnerships, convey an explanation of service-learning based on community based research so that a shared understanding is obtained on how the research will be conducted and how the roles are divided at each stage of development, conduct surveys and observations to obtain an overview of learning devices and student and teacher activities in the learning process at the Madrasah, and identify problems to obtain an overview of learning problems faced and the conditions expected by school residents regarding the learning process. The techniques used in this activity are FGD, observation, and surveys involving lecturers, madrasah principals, teachers, students, and students.

Based on the results of the observations, the following notes were obtained: (1) Teachers have not used a variety of learning resources, including the environment, and have not provided learning that produces student work, and have not given students the opportunity to ask questions/give opinions/convey ideas, (2) Students have not given opinions/asked questions/commented/explained, students have not interacted optimally with friends and/or teachers, and all students have not been active in learning.

Table 2. Learning Observation Notes

Activity		Notes
Teacher	Learners	
Asking questions that encourage students to take action to answer them.	Students carry out activities according to learning objectives	Teacher: It's optimal. Students: Need encouragement
Ask students to: provide comments; and/or answer other students' questions; and/or answer students' questions directly.	Students express their opinions/ask questions/comment/explain	Teacher: It's optimal. Students: Not yet optimal
Responding to students	Students present their work results	Teacher: It's optimal. Students: Need encouragement
Using a variety of learning resources, including the environment	Students interact with friends and/or teachers	Teacher: Not yet optimal Students: Not yet optimal
Providing learning that produces student work	Students reflect at the end of the lesson	Teacher: Not yet optimal Students: Not yet optimal

Activity		Notes
Teacher	Learners	
Give students the opportunity to ask questions/give opinions/convey ideas	All students are active in learning	Teacher: Not yet optimal Students: Not yet active

Table 3. Students' Mathematical Skills (Van De Walle, 2013)

Mathematical Skills	Explanation
Reasoning and Proof*	1. Making assumptions and constructing logical arguments in the process of solving problems. 2. Explaining the reasons for selecting/using a method/formula/strategy to solve a problem 3. Answering the question "How do you know that the answer is correct or that the method is the most appropriate?" 4. Explaining how to think
Representation*	The process of presenting an idea, concept, mathematical procedure in the form of symbols, tables, graphs, and diagrams.
Connection*	1. Recognizing and using relationships between mathematical ideas. For example, using the area of a rectangle to calculate the surface area of a cuboid. 2. Recognizing and applying mathematics to other fields. 3. Linking one or more mathematical concepts within or between mathematical units (e.g. Numbers, Geometry, Algebra) in solving mathematical tasks/problems.
Communication	1. The process of conveying, listening to, explaining, comparing, mathematical ideas/strategies, and/or reasons, orally and in writing. 2. Write down what is known, asked, before writing the answer.

Note: *Not yet optimal

Based on the results of the problem identification, it was found that students are still weak in their reasoning-proof, representation, and connection abilities and there is minimal teacher facilitation in learning that ensures an increase in reasoning-proof, representation, and connection abilities.

Implementation Stages

The service-learning implementation stage begins with the practice of service-learning which begins when students are placed in the madrasah and interact with the madrasah environment. Then involving mathematics teachers and third parties, namely lecturer facilitators in assisting the development of the MIKiR e-module. The monitoring process is carried out throughout the research process and is adjusted to the research activity agenda to monitor the development of research activities. Evaluation is carried out at the end of the research activity, to review the level of success of the research activity.

Service-Learning Practice

The practice of service learning begins when students are placed in a madrasah and interact with the madrasah environment. Students ensure that the academic support that will be completed with the work program is indeed a real problem from the community that must be solved together, not a problem that is the sole responsibility of the students. Then students consult with lecturers and collaborate with teachers regarding the study of solutions to be implemented. After that, the work plan is prepared by students together with the community/teachers.

Involvement of Teachers

The madrasah/teacher community is the main element in service-learning, the role of teachers must be clear, not only dominated by student activities. The community referred to here also includes the principal, teachers, education personnel, and students who can be a place for service-learning practices. This includes community involvement to provide input to students and on the service-learning program being carried out. Community reflection on this activity will be meaningful input for similar academic activities and input for service-learning implementers.

Involvement of third parties (in this case the Tanoto Foundation)

The involvement of third parties is very possible, especially in supporting the services and educational services that can be provided. The Tanoto Foundation was involved as a third party in assisting the development of the MIKiR e-module device which has been practically mastered by the lecturer facilitator of the Tanoto Foundation PINTAR program. So that the FGD process carried out throughout the research activity was facilitated by the lecturer facilitator of the Tanoto Foundation PNTAR Program.

Monitoring and Evaluation

The monitoring process is carried out throughout the research process and is adjusted to the research activity agenda to monitor the development of research activities. Evaluation is carried out at the end of the

research activity, to review the level of success of the research activity.

Post-Implementation
Reflection

Reflection is an important part of service-learning activities aimed at measuring the level of success of the activity. Reflection is given to students, community/teachers, third parties in order to obtain input for improving the next service-learning activity. Reflection is carried out using various methods such as interviews, discussions, sharing experiences, and various other methods.

Comprehensive Evaluation

Service-learning activities are expected to be sustainable learning activities. To support this, it is necessary to build a strong concept and commitment from all related parties, be it students, lecturers, or the community. Once the commitment is built, it will not be difficult if a comprehensive evaluation is carried out at the end of the program.

Reporting

Reporting becomes a very contextual foundation for further service-learning development. Reporting at the end of the activity becomes crucial in its existence which can be a point for knowledge management. The formal form of reporting is a joint research report with the community.

Community Based Research
Laying the Basic Principles

Community involvement with researchers in all research processes makes the community know what the purpose of the research is, what problems they face and how to overcome these problems. Thus, the community can independently build relationships within the community, share responsibilities, and build local capacity. Research results that are processed collaboratively (in the form of publications) encourage researchers together with the Community to reflect on how the knowledge obtained can provide meaningful contributions to the community being studied. In short, the basic principles of community-based research are: (1) Balanced collaboration in the research team, (2) Capacity is built internally, not by experts unilaterally, and (3) Research results are designed to empower the community being studied.

Planning

Before conducting research, there are several things that need to be done as the initial step of the Community-Based Research process. The first is where the research will take place agreed at MTs N 5 Kota Jambi. After the location of the research is clear, then it can be designed who will be involved in the research. Based on the objectives of this research, those involved are Lecturers, Teachers, and Students.

Data Collection and Analysis

Community-Based Research fully involves all stakeholders in the entire process of data collection and analysis. Researchers and communities collaborate in designing and compiling research instruments, going into the field together to collect data and then analyzing the data collaboratively.

Action on Findings

In carrying out interventions and taking action on results or findings, the following are matters related to cross-cutting issues that must be considered as a guide in carrying out follow-up research in the community: (1) Good Governance, (2) Sustainable Development, (3) Environmental Concerns, (4) Economic Sustainability, (5) Economic Sustainability, and (6) Gender Equity.

ASSURE
Analyze Learner

The activity of analyzing the characteristics of students was carried out together with the mathematics subject teacher of MTs N 5 Kota Jambi to analyze students, the school environment, assignments, learning processes and others needed in the information collection process. In conducting student analysis, several things need to be done including the general characteristics of students, initial competencies that are their basic capital, learning styles of students, psychological aspects of students according to needs.

Table 4. Student Learning Styles

Learning Styles	Indicator
Visual (Sight)*	Shows preference for pictures, diagrams, and graphs.
	Likes to see visual presentations or written materials.
	Enjoy reading books and love colors in learning.
Auditory (Hearing)	Demonstrates a tendency to understand material through hearing.
	Likes to listen to oral explanations or discussions.
	Able to remember information through hearing better than reading.
Kinesthetic (Movement)*	Learning is better through hands-on experience and practice.
	Like to move or do physical activity while studying.

Learning Styles	Indicator
	Better understand concepts through direct experience rather than theory.
Logical (Logical Thinking)	Tend to like patterns, sequences, and logical thinking.
	Prefer to solve problems and find patterns in information.
	Shows interest in science and reasoning.
Social (Social Interaction)	Demonstrates a tendency to learn through social interaction.
	Likes working in groups and sharing ideas with others.
	Better understand the material through discussion and exchange of ideas.
Solitary (Individual)	Prefer to study alone without external distractions.
	Likes time for reflection and personal thought.
	Tends to be focused and productive when working alone.
Verbal (Speaking):	Shows a preference for speaking and communicating verbally.
	Enjoys participating in class discussions and presentations.
	Better understanding of material when expressed verbally.

Note: *Majority of students' learning styles

Based on the results of the student learning style questionnaire, it was found that the majority of students have visual (sight) and kinesthetic (movement) learning styles. In addition to learning styles, learning preferences also need to be analyzed based on these learning styles. Student learning preferences can vary based on individual learning styles. Some students may be more responsive to one type of learning media than others. Based on the results of the student learning preference questionnaire, it was found that the majority of students have learning preferences using Graphics and Images, Slide Presentations, Activity-Based Learning, Simulations and Educational Games. The techniques used in this activity are Observation, interviews, FGDs, and surveys involving lecturers, teachers, students, and students.

The analysis of student characteristics is used as a consideration in determining the next development stages. Based on the analysis of student characteristics, it is concluded that: (1) Teachers have not used varied learning resources, including the environment, have not provided learning that produces student work, and have not given students the opportunity to ask questions/give opinions/convey ideas, (2) Students have not given opinions/asked questions/commented/explained, have not optimally interacted with friends and/or teachers, and all students have not been active in learning, (3) Students are still weak in the ability to reason, prove, represent, and connect and there is minimal teacher facilitation in learning that ensures an increase in the ability to reason, prove, represent, and connect, (4) The majority of students have a visual (Sight) and kinesthetic (Movement) learning style, (5) The majority of students have a learning preference using Graphics and Images, Slide Presentations, Activity-Based Learning, Simulations and Educational Games.

Table 5. Student Learning Preferences

Learning Styles	Learning Preferences
Visual*	Graphs and Images: Visual learners may prefer learning that involves graphs, diagrams, or images.
	Slide Presentations: Using slide presentations with engaging visuals can help students understand concepts better.
Auditive	Talk and Discussion: Auditory learners tend to learn through listening. Class discussions, lectures, and Q&A can be effective methods.
	Podcasts or Audio Materials: Audio materials such as podcasts or recorded lectures can be an option for students who prefer to learn by listening.
Kinesthetic*	Activity-Based Learning: Kinesthetic learners tend to learn through physical action. Hands-on activities, experiments, or simulations can help them understand concepts better.
	Whiteboard and Markers: Organizing ideas or concepts on a whiteboard using markers can be an effective method for kinesthetic learners.
Interactive*	Simulations and Educational Games: Interactive media such as simulations and educational games can attract students' attention and make learning more fun.
	Online Learning Platforms: Learners may prefer to use online learning platforms that allow them to interact with the course material.
Social	Collaboration and Joint Projects: Collaborative activities such as group projects or class discussions can cater to the preferences of learners who prefer to learn socially.
	Educational Social Media: Utilizing social media in an educational context can be an interesting option for students who are active on the platform.

Note: *Majority of students' learning preferences

State Objective

Competency analysis activities were carried out together with mathematics subject teachers at MTs N 5 Kota Jambi to obtain learning objectives (TP) and learning objective flow (ATP). In this activity, the research team analyzed the learning achievements of phase D and formulated learning objectives and learning objective flow. Learning achievements (Badan Standar, Kurikulum, dan Asesmen Pendidikan, 2022)taken from the Decree of the Head of the Education Standards, Curriculum, and Assessment Agency Concerning Learning Achievements in Early Childhood Education, Elementary Education Level, and Secondary Education Level in the Independent Curriculum. The techniques used in this activity are FGD and document analysis involving lecturers, teachers, and students.

The learning objectives that have been set are then entered into the e-module design into six e-module sections adjusted to the topics to be taught, namely the Ratio and Proportion Module, the Equivalent Comparison Module, the Inverse Comparative Value Module, the Map Making Module, the Map Scale Module, and the Rate of Change Module.

Table 6. Learning Objectives (TP) and Learning Objective Flow (ATP)

Topics	Learning objectives
Ratio and Proportion	B.34 Explain the meaning of ratio and how to write ratios
3 JP	B.35 Converting ratios into simpler forms
	B.36 Solving problems in daily life related to ratios
Comparison of Values	B.37 Explain the concept of comparative value
2 JP	B.38 Determining the comparative value of
	B.39 Solving problems in daily life related to comparative value
Inverse Ratio of Values	B.40 Explain the concept of inverse value comparison
2 JP	B.41Determine the inverse ratio of values
	B.42 Solving problems in everyday life related to value comparisons
Create a Floor Plan	B.43 Explain the concept of comparative scale
3 JP	B.44 Explain the concept of comparative scale and its relationship to ratio.
	B.45 Create a floor plan using the concept of comparative scale and relation to ratio
Scale on Maps	B.46 Explain the concept of scale on maps
3 JP	B.47 Determine the scale, if other elements are known
	B.48 Determine the distance on the map, if the other elements are known
	B.49 Determine the actual distance, if the other elements are known
Rate of Change	B.50 Explain the meaning of speed
3 JP	B.51 Explain the meaning of debit
	B.52 Solve problems related to ratios and rates of change (speed and discharge) in contextual problems.

Select Methods, Media, and Materials

The activity of selecting methods, media, and teaching materials is carried out together with lecturers, teachers, and students with the aim of obtaining a plan for using methods, media, and teaching materials in the e-module. The technique used in this activity is FGD involving lecturers, teachers, and students. Based on the data obtained from the stages of analyzing student characteristics and competency analysis, the following plan is prepared:

Method

The method used is Active Learning Experiencing, Interaction, Communication, and Reflection (MIKiR) to improve mathematical abilities through mathematical processes. (Program PINTAR Tanoto Foundation, 2018).

Table 7. MIKiR Active Learning Method

Active Learning Elements	Activity	Active Learning Elements	
Experience	Observing	Communication	Demonstrate
	Conducting an experiment		Explain
	Interview		Tell a story
	Make something		Reporting (Oral/written)
Interaction	Discuss		Expressing opinions/thoughts
	Asking/questioning		Speak
	Asking for opinion	Reflection	Rethinking your own work/thoughts
	Leave a comment		

Active Learning Elements	Activity	Active Learning Elements
	Working in groups Explaining each other's work results Answering teacher's questions	

Media

Table 8. E-Module Development Media

Media	Function
	Microsoft Word is used as a working paper for writing e-modules/draft e-modules. The ease and practicality of using Word in designing e-modules made the research team decide to use Microsoft Word in drafting e-modules.
	Microsoft Power Point is used as a working paper for writing teaching materials that will be embedded on the Google Site work page. The ease of reading materials by students in presentation format made the research team decide to use Microsoft Power Point in developing e-module teaching materials.
	Nitro Pro 13 pdf is used as an application/media for creating e-modules. The pdf format is chosen as an e-module format that can be read and studied electronically using teacher and student devices, including those that can be read on mobile phones/smart phones, tablets, laptops, and desktop PCs. The ease and practicality of studying e-modules in pdf format made the research team decide to use Nitro Pro 13 as a medium for developing e-modules.
	Canva is used to design the cover and layout of the e-module both in e-modules with pdf format and google site web pages. The ease of practicality and many features on Canva in designing e-modules made the research team decide to use Canva as a medium for developing e-modules.
	Youtube is used as a broadcast material and simulation of mathematics learning on e-modules embedded in PDF pages or Google Site web pages. The ease and practicality of using YouTube videos in designing e-modules made the research team decide on YouTube as the media for developing e-modules.
	Google Site is used as a publication media for e-modules in addition to pdf format. The ease and practicality of using Google Site as a web-based learning media and the many development features that can be adjusted in the development of media and teaching materials made the research team decide on Google Site as a media for developing e-modules.

Teaching materials

Several e-module components were developed in accordance with the teaching module provisions of the Ministry of Education, Culture, Research, and Technology. (Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi, 2022). In general, teaching modules have three main components, namely: (1) Learning Objectives, (2) Learning Steps or Learning Activities, and (3) Learning Assessment. In full, teaching modules consist of teaching module identity, teaching modules per meeting, and teaching module attachments. The government gives teachers the freedom to adjust the format of teaching modules according to the needs of each teacher in each education unit.

Table 9. Teaching Module Components

Teaching Module Identity	Teaching Module Per Meeting	Attachment
Learning module achievement phase	Meaningful Understanding	Activity sheet
Class	Starter question	Assessment rubric
Number of teaching hours	Indicators of success	Other relevant teaching materials
Learning model	Assessment	
Learning objectives	Facilities and infrastructure	
Dimensions of Pancasila	Activity plan	
Prerequisite Knowledge/Skills		

Based on the results of observations, problem identification, and analysis of student characteristics above, the development of e-modules essentially aims to facilitate: (1) Teachers in using a variety of learning

resources, including the environment, providing learning that produces student work, and providing opportunities for students to ask questions/express opinions/convey ideas, (2) Students in expressing opinions/asking questions/commenting/explaining, students optimally interacting with friends and/or teachers, and all students being active in learning, (3) Students in the ability to reason, prove, represent, and connect and teacher facilitation in learning that ensures an increase in the ability to reason, prove, represent, and connect, (4) Students who predominantly have visual (Sight) and kinesthetic (Movement) learning styles, and (5) Students who predominantly have learning preferences using Graphics and Images, Slide Presentations, Activity-Based Learning, Simulations and Educational Games. Therefore, it is perceived/suspected that Active Learning of Experiencing, Interaction, Communication, and Reflection (MIKiR) which uses publication media in PDF and Google Site formats and is arranged in an electronic teaching module (e-module) can facilitate and resolve the above problems.

Utilize Media and Materials

E-Module Components/Elements

E-Modules are developed in two publication formats, namely PDF format and Google Site format. E-modules in PDF format consist of e-module cover, e-module identity, teaching modules per meeting, and attachments. While e-modules in Google Site format consist of the e-module home page and the e-module content page which includes learning outcomes, learning objectives, learning materials/activities/LKPD, videos/simulations, and assessments.

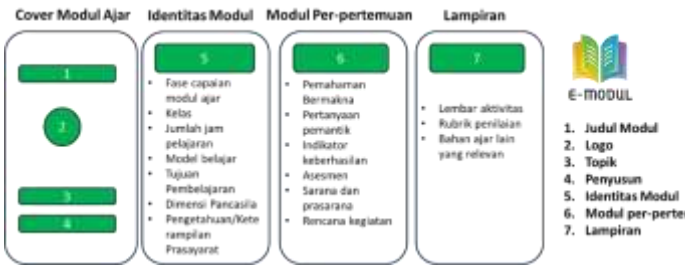

Figure 2. PDF Format E-Module Prototype

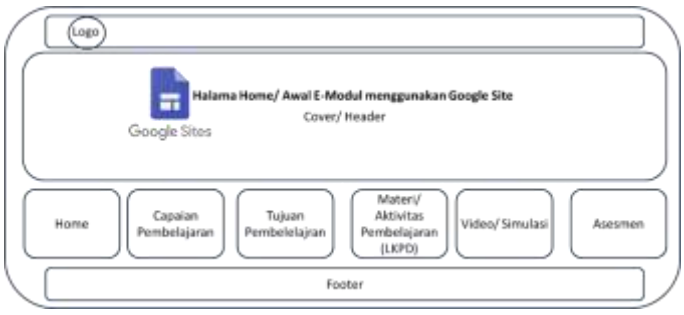

Figure 3. Google Site Home Page E-Module Prototype

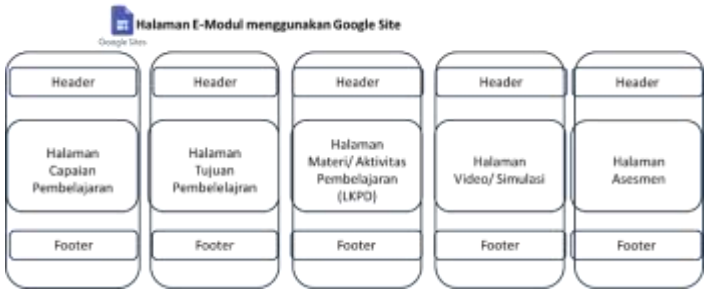

Figure 4. E-Module Prototype Google Site E-Module Content Page

E-module Content

The e-module cover contains the e-module title, e-module logo, topic, and compiler. The e-module identity contains the module achievement phase, class, number of hours, learning model, learning objectives, Pancasila student profile dimensions, and prerequisite knowledge/skills. The per-meeting module contains meaningful understanding, trigger questions, success indicators, assessments, facilities and infrastructure, and activity plans. The appendix contains activity sheets/LKPD, assessment rubrics, and relevant teaching materials.

The novelties resulting from this development include components of learning scenarios/activity plans and activity sheets/LKPD that facilitate active learning through experiencing, interaction, communication, and reflection (MIKiR) to improve mathematical reasoning, proof, representation, connection, and communication (PRKoKo) through the mathematical process of discovery, investigation, and problem solving (PPPM). This will be discussed in detail in the learning sub-organization in the following e-module.

Learning Organization in E-Modules (Content/Content Validation Evaluation of E-Modules)

Ensuring that the objectives of e-module development are achieved is something that must be done, including discussing and agreeing on the components and learning organizations that should occur in the e-module through FGD activities involving lecturers, teachers, students, and lecturer facilitators. Here are some validation evaluation formats discussed in the FGD activities for e-module development.

Learning Scenario

The research team facilitated by the lecturer facilitator conducted FGD to evaluate the e-module learning activities with the validity evaluation indicators in the table above. Based on the results of the FGD and recommended improvements, it was concluded that the learning activities in the e-module met the learning criteria that facilitate active learning experiences, interactions, communications, and reflections (MIKiR) and can develop mathematical reasoning-proof,

representation, connections, and communications (PRKoKo) abilities and are carried out through the mathematical process of inquiry-discovery and problem solving (PPPM).

Table 10. Evaluation of Learning Activities in the E-Module

Evaluation Components	Indicator	FGD Results
Evaluation of Learning Objectives	Are the learning objectives clear?	√
	Are there any specific subject skills reflected in the learning objectives?	√
	characteristics of students who have achieved this learning objective? What are the indicators that this learning activity is successful (covering the answers to the first and second questions)?	√
Evaluation of Learning Activities	To what extent can the learning scenario achieve the established learning objectives?	√
	Has the apperception conducted linked the concept to be learned with the prior knowledge that students already have?	√
	How do Core and Closing Activities describe MIKiR?	√
	MIKiR Components — Discussion results	
	Experience — Activities that reflect: √	
	Experience — Relevance to objectives: √	
	Interaction — Activities that reflect: √	
	Interaction — Relevance to objectives: √	
	Activities that reflect: √	
	Relevance to objectives: √	
	Reflection — Activities that reflect: √	
	Reflection — Relevance to objectives: √	
	Is the overall sequence of activities logical?	√
	Are the steps that students must take clear? If not, which parts need to be clarified?	√
	Has scaffolding occurred? In which activity components has the scaffolding process occurred?	√
	How can this scenario develop the processes and skills unique to the subject in question?	√
	If you position yourself as a student, are you able to understand the topic through the existing activities?	√
	Can the designed activities be done by students with different levels of mastery of the material? If not, what support options or backup activities will you offer to ensure that all students can understand the topic?	√
	Has there been a learning evaluation process in this scenario?	
	- If yes, can the process actually capture the desired learning outcomes?	√
	- If not, how would you design the evaluation process?	

Description: (√) Fulfilled after FGD and improvements were carried out

Activity Sheet

The research team facilitated by the lecturer facilitator conducted FGD to evaluate the activity sheets/LKPD in the e-module with the validity evaluation indicators in the table above. Based on the results of the FGD and recommended improvements, it was concluded that the activity sheets/LKPD in the e-module met the criteria for achieving learning objectives and encouraging students to act (productively) and supporting the creation of active learning experiences, interactions, communications, and reflections (MIKiR) and can develop mathematical reasoning-proof, representation, connections, and communications (PRKoKo) abilities and are carried out through the mathematical process of investigation-discovery and problem solving (PPPM).

Table 11. Evaluation of Activity Sheets/LKPD in E-Modules

Evaluation Components	Indicator	FGD Results
General Evaluation	How can this LKPD or assignment achieve the expected learning objectives?	√
	Does this LKPD or assignment encourage students to DO?	√
Review the components of the LKPD or student work results based on the following aspects!		√
Context/Information Evaluation	Does the context/information in the LKPD inspire students to the right extent to answer the questions?	√

Evaluation Components	Indicator	FGD Results
	Remember: if there is too little context, then students do not have enough information to answer the question. If there is too much context, then it will hinder students' productivity in thinking or answering.	
Evaluation Questions	Are the instructions and questions clear? Do students know exactly what they are supposed to do?	√
	Is the sequence of questions logical and is the thinking process sequential?	√
	Do the questions in the LKPD encourage students to imagine or look for more than one correct answer?	√
	Does the LKPD encourage students to write down the results of experiments/observations/interviews/or others?	√
	Are there any questions that help students conclude what they got at the end of the LKPD?	√
	If there is a question that is unclear or illogical, how would you improve the question?	√
Differentiation evaluation	Can the assignments be completed by students with different levels of mastery of the material? If not, what assistance options will you offer to ensure that all students can complete the assignments?	√

Description: (√) Fulfilled after FGD and improvements were carried out

E-Module Publication (E-Module Design Validation Evaluation)

Table 12. Evaluation of E-Module Publication Design

Evaluation Components	Indicator	FGD Results
Screen Design View	The composition of the text color against the background color.	√
	Proportional layout (text and images).	√
	Layout of each section	√
	Synchronization or relationship between illustrations, graphics, visuals, and verbal.	√
	Clarity of title and content of e-module.	√
	Has an attractive e-module design (colors, images/illustrations and letters).	√
Ease of Use	Presented sequentially according to the sections.	√
	Easy to operate with laptop/PC/smartphone/Tablet.	√
	The content within the e-module is easily accessible.	√
	Operational buttons work properly.	√
Consistency	The words, terms and sentences in the learning materials are consistent.	√
	The shape and size of the letters are consistent.	√
	The layout of the display is consistent.	√
Graphics	The use of color is appropriate.	√
	The size and font are easy to read clearly.	√
	The illustrations/images used are clear.	√
	The video/simulation runs smoothly and clearly.	√
	The video/simulation narration is clearly audible and understandable.	√
Usefulness	The steps in the e-module are clear.	√
	Teachers/educators can interact using e-modules easily.	√
	Students can interact using e-modules easily.	√

Description: (√) Fulfilled after FGD and improvements were carried out

The research team facilitated by the lecturer facilitator conducted FGD to evaluate the e-module publication design with the validity evaluation indicators in the table above. Based on the results of the FGD and recommended improvements, it was concluded that the e-module publication design met the criteria for an attractive screen design display, easy to use, consistent, displaying proportional and clear graphics, and being useful for teachers and students that support the creation of active learning experiences, interactions, communication, and reflections (MIKiR) and can develop mathematical reasoning-proof, representation, connection, and communication (PRKoKo) skills and is carried out through the mathematical process of inquiry-discovery and problem solving (PPPM).

Required Learner Participation

Empirical validation evaluation is intended to determine whether the e-module created is in accordance with the needs of students effectively and efficiently (Kemdikbud, 2017). This can be done by observing learning activities and to prove whether the e-module can help and can be used by students in learning to meet learning standards.

Practicality

Table 13. Evaluation of the Practicality of the E-Module (Marlini & Rismawati, 2019).

Practicality Aspect	Teacher Response
Ease of use of e-modules	Easy to use in the learning process both online and offline.
Time efficient use of e-modules	Time management becomes more controlled.
Compliance with competencies	Can achieve the learning objectives taught.
Attractiveness	Very interesting and challenging learning process.
Can be used as independent learning	Students can independently utilize this e-module.

Based on the results of empirical tests of the application of learning using e-modules, it was concluded that e-modules meet the criteria of practicality, namely: (1) Ease of use of e-modules, (2) Efficient time for using e-modules, (3) Suitability to competencies, (4) having appeal, and (5) Can be used as independent learning for students.

Effectiveness

Table 14. Percentage of Learning Activity Using E-Modules

Active Learning Elements	Indicator	Teacher Response		Student Response		Percentage (Yes)
		Yes	No	Yes	No	
Experience	1. Observing	2	0	55	5	92%
	2. Conducting an experiment	2	0	48	12	80%
	3. Interview	0	2	0	60	0%
	4. Memake something	2	0	58	2	97%
Interaction	5. Discuss	2	0	60	0	100%
	6. Ask/question	2	0	50	10	83%
	7. Meask for opinion	2	0	48	12	80%
	8. Meleave a comment	2	0	51	9	85%
	9. Working dgroup nature	2	0	60	0	100%
	10. Each otherexplain the results of work	2	0	56	4	93%
	11. Menanswer the teacher's questions	2	0	50	10	83%
Communication	12. MendeDemonstrate	2	0	49	11	82%
	13. Explain	2	0	56	4	93%
	14. Tell a story	1	1	0	60	0%
	15. Reporting (Oral/written)	2	0	45	15	75%
	16. Expressing opinions/thoughts	2	0	59	1	98%
	17. Speak	2	0	54	6	90%
Reflection	18. Rethinking your own work/thoughts	2	0	57	3	95%

Table 15. Percentage of Mathematical Ability in Learning Using E-Modules

Math Skills	Explanation	Teacher Response		Student Response		Percentage (Yes)
		Yes	No	Yes	No	
Reasoning and Proof	1. Making assumptions and constructing logical arguments in the process of solving problems.	2	0	52	8	87%
	2. Explaining the reasons for selecting/using a method/formula/strategy to solve a problem	2	0	50	10	83%
	3. Answering the question "How do you know that the answer is correct or that the method is the most appropriate?"	2	0	40	20	67%
	4. Explaining how to think	2	0	48	12	80%
Representation	5. The process of presenting an idea, concept, mathematical procedure in the form of symbols, tables, graphs, and diagrams.	2	0	60	0	100%
Connection	6. Recognizing and using relationships between mathematical ideas. For example, using the area of a rectangle to calculate the surface area of a cuboid.	2	0	53	8	88%
	7. Recognizing and applying mathematics to other fields.	1	1	48	12	80%

Math Skills	Explanation	Teacher Response		Student Response		Percentage (Yes)
		Yes	No	Yes	No	
Communication	8. Linking one or more mathematical concepts within or between mathematical units (e.g. Numbers, Geometry, Algebra) in solving mathematical tasks/problems.	2	0	58	2	97%
	9. The process of conveying, listening to, explaining, comparing, mathematical ideas/strategies, and/or reasons, orally and in writing.	2	0	60	0	100%
	10. Write down what is known, asked, before writing the answer.	2	0	60	0	100%

Based on the results of teacher and student responses regarding learning using e-modules, it was found that most (≥ 80%) of students responded that the learning implemented facilitated them in reasoning-proof, representation, connection, and communication activities. Except for the indicator Answering the question "How do you know that the answer is correct or that the method is the most appropriate?". This is because the possibility of the activity being missed by students on the grounds that it is not necessary because it is clear. So it can be concluded that learning using the MIKiR e-module can facilitate the development of mathematical reasoning-proof, representation, connection, and communication (PRKoKo) abilities.

Table 16. Mathematics Learning Process Using E-Modules

Mathematical process	Indicator	Is there any or not	
		Teacher Response	Student Response
Investigation-Discovery	Observing the effect of changes in one element on other elements. Finding the formula. Finding traits/characteristics. Finding number patterns. Finding geometric patterns.	There is	There is
Solution to problem	Find a way/strategy first before solving the problem	There is	There is

(Program PINTAR Tanoto Foundation, 2019)

Based on the results of teacher and student responses about learning using e-modules, it was found that students responded to the learning implemented to facilitate them in the process of mathematical inquiry-discovery and problem solving. So it can be concluded that learning using the MIKiR e-module can facilitate the process of mathematical inquiry-discovery and problem solving (PPPM).

Next, based on the results of learning observations using the MIKiR e-module, teachers are optimal in the following areas: (1) Asking questions that encourage students to take action to answer them, (2) Asking students to: give comments; and/or answer other students' questions; and/or answer students' questions directly, (3) Responding to students, (4) Using a variety of learning resources, including the environment, (5) Providing learning that produces student work, and (6) Giving students the opportunity to ask questions/give opinions/convey ideas.

Table 17. Learning Observation Notes

Activity		Notes
Teacher	Learners	
Asking questions encourages students to take action to answer them.	Students carry out activities according to learning objectives	Teacher: Optimal Students: Optimal
Ask students to: provide comments; and/or answer other students' questions; and/or answer students' questions directly.	Students express their opinions/ask/comment/explain	Teacher: Optimal Students: Optimal
Responding to students	Students present their work results	Teacher: Optimal Students: Optimal

Activity		Notes
Teacher	Learners	
Using a variety of learning resources, including the environment	Students interact with friends and/or teachers	Teacher: Optimal Students: Optimal
Providing learning that produces student work	Students reflect at the end of the lesson	Teacher: Optimal Students: Optimal
Give students the opportunity to ask questions/give opinions/convey ideas	All students are active in learning	Teacher: Optimal Students: Optimal

Based on the results of empirical tests of learning using the MIKiR e-module that have been carried out, it can be concluded that learning meets the evaluation of practicality, namely (1) Ease of use of the e-module, (2) Efficient time of use of the e-module, (3) Suitability with competencies, (4) has appeal, and (5) Can be used as independent learning for students. And also meets the evaluation of effectiveness, namely (1) facilitating active learning experiences, interactions, communication, and reflection (MIKiR), (2) developing mathematical reasoning-proof, representation, connection, and communication (PRKoKo) abilities, (3) facilitating the mathematical process of investigation-discovery and problem solving (PPPM), and (4) optimal in a quality learning process.

Evaluate and revise

After carrying out the learning process, evaluation and revision are then carried out. This stage aims to evaluate the effectiveness and efficiency/practicality of the learning program using e-modules, then periodic revisions are carried out according to the evaluation results. The evaluation and revision process is carried out at each stage of development starting from the state objective stage, the select methods, media, and materials stage, the utilize media and materials stage, and the required learner participation stage. The results of the evaluation and revision are displayed in the data in each sub-stage of the previous development. The technique used in this activity is FGD with a research team of lecturers, teachers, and students so that a valid, practical, and effective e-module is produced.

Collaboration Model between Lecturers, Teachers, and Students

Based on the collaborative process of developing the MIKiR e-module through service-learning community based research that has been carried out, a collaboration model of lecturers, teachers, and students was obtained which was designed based on what the goals of each individual involved are and what their respective responsibilities are in the research. (1) Lecturer Researchers aim to disseminate knowledge through research and community service with the responsibility as leaders in this research process, (2) Mathematics Subject Teachers aim to develop innovative learning with the responsibility as partners who can provide input for the smooth running of this research, and (3) Students aim to apply the knowledge they have on campus to real situations in schools/madrasas with the responsibility as partners who can provide technical assistance in implementing this research. All research members, namely lecturers, teachers, and students, have a role in determining the steps and processes of the research carried out, including considering and deciding something which of course goes through a process of deliberation and consensus first. The following is a summary of the collaboration model of lecturers, teachers, and students:

Table 18. Collaboration Model between Lecturers, Teachers, and Students

Activity	Technique	Who Plays a Role
Initiating communication	Discussion	Lecturer
Cooperation and partnership agreement	Discussion	Lecturer
CBR Based Service-learning Explanation	FGD	Lecturer, Teacher, Student
Service-learning practices	Observation, Interview, Document Analysis, FGD	Lecturer, Teacher, Student
Observation of the learning environment	Observation	Lecturer, Teacher, Student
Identification of problems	Observation, Interview, Document Analysis	Lecturer, Teacher, Student
Analyzing student characteristics	FGD	Lecturer, Teacher, Student
Establishing competencies (Competency Analysis)	Document Analysis	Lecturer, Teacher, Student
Selecting methods, media and teaching materials (Pedagogical Analysis)	Discussion, Document Analysis, FGD	Lecturer, Teacher, Student
Utilizing media and teaching materials (e-module prototype)	Discussion, Document Analysis, FGD	Lecturers, Teachers, Students, Social Services

Activity	Technique	Who Plays a Role
Involving students in the learning process (Trial)	Observation	Lecturer, Teacher, Student
Evaluate and revise	Interview, discussion, Document Analysis, FGD	Lecturers, Teachers, Students, Learners, Social Facility
Third party involvement (Fasdos Tanoto Foundation)	Discussion, Document Analysis	Lecturers, Teachers, Students, Social Services
Monitoring and evaluation	Discussion, Observation, Document Analysis, FGD	Lecturer, Teacher, Student
Data Analysis	FGD	Lecturer, Teacher, Student
Reflection	FGD	Lecturer, Teacher, Student
Reporting	FGD	Lecturer, Teacher, Student

Discussion

This development research involves lecturers, teachers, and students in collaborating to develop e-modules that can facilitate active learning through experience, interaction, communication, and reflection (MIKiR) to improve mathematical reasoning-proof, representation, connection, and communication (PRKoKo) skills through the mathematical process of inquiry-discovery and problem solving (PPPM). The involvement of teachers and students as equal partners is a strategic step to identify knowledge and maximize the use of research. (Small & Uttal, 2005); (Wallerstein & Duran, 2017).

Collaboration between lecturers, teachers and students through the Service-learning (SL) approach emphasizes practical aspects with the involvement of students and the community, in this case teachers, in its implementation. (Kambau, Kadir, Mutmainnah, Jamilah, & Rahman, 2016). While Community Based Research provides space for the unification of theory and practice, reflecting theory through practice and implementing practice through theory. Community Based Research enriches the understanding of how to carry out research collaboration between communities and academics so that every individual in the community gets the opportunity to collectively be involved in improving their competence. (Susilawaty, Tasruddin, Ahmad, & Salenda, 2016).

This development research provides an opportunity for the community/teachers and students to be involved in every stage of the development research starting from the CBR-based service-learning explanation activities, service-learning practices, observation of the learning environment, identification of problems, analyzing student characteristics, determining competencies (competency analysis), choosing methods, media and teaching materials (pedagogical analysis), utilizing media and teaching materials (e-module prototype), involving students in the learning process (trial), evaluating and revising, involving third parties (Fasdos Tanoto Foundation), monitoring and evaluation, data analysis, reflection, and reporting. This involvement and role is based on the CBR principle which offers various levels of participation and roles carried out by the community, including (1) The community can play a role only within certain stages, (2) The community can be involved from formulating research questions, research design to data collection but not involved in analysis and report preparation. (Susilawaty, Tasruddin, Ahmad, & Salenda, 2016).

Collaboration of lecturers, teachers, and students through service-learning community based research (SLCBR) in developing the MIKiR e-module using the research and development (RnD) type with ASSURE design. (Heinich, Molenda, Russel, & Smaldino, 2002)which consists of 6 stages, namely: (1) Analyze learners, (2) State objectives, (3) Select methods, media, and materials, (4) Utilize media and materials, (5) Required learner participation, and (6) Evaluate and revise. This design has also been used by Ramadhani & Fitri (2021) in developing e-modules and by Kim & Downey (2016) in empirically proving that the ASSURE approach is practical and easy to implement to integrate technology into classroom teaching. In accordance with the results of collaborative research conducted by researchers, the development of the MIKiR e-module with the ASSURE model through service-learning community based research (SLCBR) has obtained an e-module that is practical and effective to apply in learning.

Integration of ICT into the learning process is necessary to develop students' high-level thinking skills, develop skills in the field of ICT (ICT Literacy), and to increase the effectiveness, efficiency and attractiveness of the learning process. (Pusdatin Kemendikbudristek, 2021). The use of e-modules also provides new learning experiences in building students' knowledge. (Jaenudin, Baedhowi, & Murwaningsih, 2017). Furthermore, the use of e-modules provides benefits: (1) Teachers can digitally control the learning process of students, (2) Teachers do not only provide teaching in class, but also outside the classroom, (3) Offer individual learning opportunities for students so that they can learn to solve problems in their own way, and (4) Make learning easier to implement, because it can be used not only during

face-to-face learning in class, but can be used anywhere and anytime. (Hamzah & Mentari, 2017).

Conclusion

The development of MIKiR e-modules through service-learning community-based research is essential as it addresses key challenges faced by students, teachers, and lecturers. Students possess theoretical knowledge but lack opportunities for direct application, making service-learning necessary. Teachers, while skilled in teaching, often struggle to develop innovative learning methods, further emphasizing the need for service-learning. Meanwhile, lecturers have the responsibility to disseminate knowledge through research and community engagement, highlighting the importance of community-based research.

The findings of this study demonstrate that the developed MIKiR e-modules are both valid and effective in facilitating active learning through experience, interaction, communication, and reflection (MIKiR). They also enhance students' mathematical reasoning-proof, connection representation, and communication (PRKoKo) skills while supporting the mathematical process of investigation, discovery, and problem-solving (PPPM). Furthermore, the MIKiR e-module is proven to be practical, offering ease of use, efficient learning time, alignment with competency standards, engaging content, and the potential for independent learning.

The collaboration model among lecturers, teachers, and students in this study was structured based on their individual goals and responsibilities within the research process. Lecturers played a crucial role in leading the research and disseminating knowledge, teachers contributed as partners providing input to refine the research, and students acted as collaborators, applying their theoretical knowledge in real-world classroom settings. All members actively participated in decision-making through deliberation and consensus, ensuring a cooperative and inclusive research process.

Based on these conclusions, several recommendations can be proposed. First, universities and schools/madrasas should establish structured partnership programs to strengthen collaboration. Second, lecturers, teachers, and students should utilize the service-learning community-based research approach to enhance professionalism, productivity, and learning innovation, ultimately improving the quality of education at both school and university levels. Lastly, future research should explore the implementation of the Merdeka curriculum through a service-learning community-based research approach, integrating it with development research, experimental studies, and other qualitative methodologies to expand its impact on educational practices.

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Author Contributions

All authors consisting of Darma Putra, Abul Walid, Try Susanti, and Andi Asari contributed to the research process starting from searching for references, compiling the research framework and methods, data collection, data processing, and writing the article.

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Declare conflicts of interest or state "The authors declare no conflict of interest." Authors must identify and declare any personal circumstances or interests that may be perceived as inappropriately influencing the representation or interpretation of reported research results. Any role of the funders in the design of the study; in the collection, analysis or interpretation of data; in the writing of the manuscript; or in the decision to publish the results must be declared in this section. If there is no role, please state "The funders had no role in the design of the study; in the collection, analysis, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results".

References

Asrial, Syahrial, Kurniawan, D. A., & Anandari, S. Q. (2019). Digitalization of Ethno Constructivism Based Module for Elementary School Students. *Jurnal Ilmu Pendidikan, 25*(1), 33-41. http://dx.doi.org/10.17977/um048v25i1p33-41

Badan Standar, Kurikulum, dan Asesmen Pendidikan. (2022). *Keputusan Kepala Badan Standar, Kurikulum, dan Asesmen Pendidikan Tentang Capaian pembelajaran pada Pendidikan Anak Usia Dini, Jenjang pendidikan Dasar, dan Jenjang Pendidikan Menengah pada Kurikulum Merdeka.* Jakarta: Kementerian Pendidikan, Kebudayaan, Riset dan Teknologi.

Darma, R. S., Setyadi, A., Wilujeng, I., Jumadi, & Kuswanto, H. (2019). Multimedia Learning Module

Development based on SIGIL Software in Physics Learning. *IOP Conf. Series: Journal of Physics: Conf. Series 1233* (pp. 1-7). IOP Publishing. http://dx.doi.org/10.1088/1742-6596/1233/1/012042

Fauziah, Z. I., Sutrisno, & Suwarni. (2016). Pengembangan E-Modul Berbasis Adobe Flash CS6 pada Mata Pelajaran Penataan Barang Dagang. *Jurnal Pendidikan Bisnis dan Manajemen, 2*(2), 154-159. https://journal2.um.ac.id/index.php/jpbm/article/view/1703

Fonda, A., & Sumargiyani, S. (2018). The developing math electronic module with scientific approach using kvisoft flipbook maker pro for XI grade of senior high school. *Infinity Journal, 7*(2), 109-122. https://doi.org/10.22460/infinity.v7i2.p109-122

Hamzah, I., & Mentari, S. (2017). Development of Accounting E-Module to Support the Scientific Approach of Students Grade X Vocational High School. *Journal of Accounting and Business Education, 2*(1), 78-88. http://dx.doi.org/10.26675/jabe.v1i1.9751

Heinich, R., Molenda, M., Russel, J. D., & Smaldino, S. E. (2002). *Instructional Media and Technologies for Learning 7th ed.* Upper Saddle River, New Jersey: Pearson Education, Inc.

Jaenudin, A., Baedhowi, & Murwaningsih, T. (2017). The Effectiveness of the E-Module of Economics Learning on Problem-Based Learning used to Improve Students' Learning Outcomes. *Advances in Social Science, Education and Humanities Research, 158*, 30-36. https://doi.org/10.2991/ictte-17.2017.32

Kambau, R. A., Kadir, N. A., Mutmainnah, Jamilah, & Rahman, A. (2016). *Panduan Implementasi Service Learning*. Makasar: Nur Khairunnisa.

Kemdikbud. (2017). *Panduan Praktis Penyusun e-Modul*. Jakarta: Ditjen Pendidikan Dasar dan Menengah.

Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi. (2022). Modul Ajar. *Paparan Materi Modul Ajar Kurikulum Merdeka*. Jakarta: Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi.

Kim, D., & Downey, S. (2016). Examining the Use of the ASSURE Model by K–12 Teachers. *Computers in the Schools, 33*(3), 153-168. http://dx.doi.org/10.1080/07380569.2016.1203208

Marlini, C., & Rismawati. (2019). Praktikalitas Penggunaan Media Pembelajaran Membaca Permulaan Berbasis Macromedia Flash. *Jurnal Tunas Bangsa, 6*(2), 277-289. Reteieved from https://ejournal.bbg.ac.id/tunasbangsa/article/view/965

Matanluk, O., Mohammad, B., & Imbug, M. (2013). The Effectiveness of Using Teaching Module based on Radical Constructivism toward Students Learning Process. *Procedia - Social and Behavioral Sciences*, 607-615. http://dx.doi.org/10.1016/j.sbspro.2013.07.132

Menteri pendidikan Nasioanal. (2007). *Peraturan Menteri Pendidikan NasionalNomor 16 Tahun 2007 Tentang Standar Kualifikasi Akademik dan dan Kompetensi Guru*. Indonesia: Kementerian Pendidikan Nasional.

Nursolekah, S., & Suparman. (2019). Design of mathematics learning module based on problem based learning to improve critical thinking ability students. *International Journal of Scientific & Technology Research, 8*(12), 2608-2616.

Program PINTAR Tanoto Foundation. (2018). *Modul I: Praktik yang Baik dalam Pembelajaran di SMP dan MTs.* Jakarta: Tanoto Foundation.

Program PINTAR Tanoto Foundation. (2019). *Modul II: Praktik yang Baik dalam Pembelajaran di SMP dan MTs Matematika.* Jakarta: Tanoto Foundation.

Pusdatin Kemendikbudristek. (2021, Juni 23). *Pembelajaran Berbasis TIK (PembaTIK) dalam Meningkatkan Level Kompetensi TIK Guru di Indonesia*. Retrieved from https://pusdatin.kemdikbud.go.id/: https://pusdatin.kemdikbud.go.id/pembelajaran-berbasis-tik-pembatik-dalam-meningkatkan-level-kompetensi-tik-guru-di-indonesia/

Ramadhani, R., & Fitri, Y. (2021). EPUB3 Based Mathematical E-Modules Using the Sigil Application as A Solution in Teaching and Learning Process Through Covid-19 Pandemic. *Formatif: Jurnal Ilmiah Pendidikan MIPA, 11*(1), 35-48.

Ratheeswari, K. (2018). Information Communication Technology in Education. *Journal of Applied and Advanced Research*, S45-S47. http://dx.doi.org/10.30998/formatif.v11i1.6826

Sanjaya, B., Walid, A., & Sefrinando, B. (2022). *Eksploratori Sekuensial TPACK Guru Madrasah di Jambi.* Jambi: Lembaga Penelitian dan Pengabdian (LPPM) UIN Sultahan Thaha Saifuddin Jambi.

Small, S., & Uttal, L. (2005). Action-Oriented Research: Strategies for Engaged Scholarship. *Journal of Marriage and Family*, 936-948. http://dx.doi.org/10.1111/j.1741-3737.2005.00185.x

Susilawaty, A., Tasruddin, R., Ahmad, D., & Salenda, K. (2016). *Panduan Riset Berbasis Komunitas.* Makasar: Nur Khairunnisa.

Syahrul, S. A., Murni, A., & Siregar, S. N. (2019). Implementation of problem based Learning model to improve student's mathematical problem

solving skill at class VIIIA 2 MTs darul hikmah pekanbaru. *JOM FKIP, 6*(1), 1-12.

Van De Walle, J. A. (2013). *Elementary and Middle School Mathematics: Teaching Developmentally.* USA: Pearson Education Inc.

Wallerstein, N., & Duran, B. (2017). The theoretical, historical, and practice roots of CBPR. In N. Wallerstein, B. Duran, J. Oetzel, & M. Minkler, *Community based participatory research for health* (pp. 25-46). San Francisco, CA: Jossey Bass.